A Conservation Assessment for the White-headed woodpecker (*Picoides albolarvatus*)

2013

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Disclaimer

This Conservation Assessment was prepared as a compilation of published and unpublished information regarding the biology and status of the White-headed woodpecker (*Picoides albolarvatus*). This assessment does not represent a management decision by the US Forest Service (FS Region 6) or Bureau of Land Management (OR/WA BLM). This report draws upon primary sources, summary articles, literature compilations, and observations from field researchers. Although the best scientific information available was used in preparation of this document, it is expected that new information will be forthcoming. Questions or information updates related to this document should be directed to the Interagency Special Status and Sensitive Species Conservation Planning Coordinator (Forest Service Region 6 and OR/WA BLM) in Portland, Oregon: www.fs.fed.us/r6/sfpnw/issssp/contactus/.

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Executive Summary

The goal of this Conservation Assessment (CA) is to summarize existing information on the biology, ecology, habitat use and threats to the White-headed woodpecker (*Picoides albolarvatus*). Management considerations for the species are also given. A separate, detailed monitoring strategy has been developed as a supplement to this document.

Management Status

The White-headed woodpecker is listed as Sensitive on the BLM Special Status Species List (2012) and on the US Forest Service Region 6 Regional Forester's Sensitive Species List (2012) for both Oregon and Washington. Oregon Department of Fish and Wildlife has listed the species as "Critical" and Washington Department of Wildlife has listed it as a "Candidate" for listing as Endangered, Threatened, or Sensitive. The woodpecker is identified by U.S. Fish and Wildlife Service as a species of conservation concern. NatureServe ranks the White-headed woodpecker as a G4, but as S2S3 in both Oregon and Washington.

Biology and Ecology

White-headed woodpeckers are cavity nesting birds strongly associated with coniferous forests dominated by pines. They are residents from south-central British Columbia, north-central Washington and northern and western Idaho south through eastern and southwest Oregon to southern California and west-central Nevada (AOU 1983, Garrett et al. 1996). White-headed woodpeckers range from very rare in British Columbia to common further south in their range in California.

In Oregon and Washington, White-headed woodpeckers occur primarily in open ponderosa pine (*Pinus ponderosa*) or dry mixed-conifer forests dominated by ponderosa pine (Bull et al. 1986, Dixon 1995a, Frenzel 2004, Buchanan et al. 2003). They also use burned forests (Saab and Dudley 1988, Wightman et al. 2010). Nesting usually occurs in open ponderosa pine forests with higher number of large trees and snags than the surrounding forest (Buchanan et al. 2003, Frenzel 2004, Hollenbeck et al. 2011). The woodpeckers typically excavate nest cavities in large, moderately decayed, ponderosa pine snags (Buchanan et al. 2003, Dixon 1995a, Frenzel 2004). The birds forage in ponderosa pine trees in stands with higher canopy closure than nest stands (Dixon 1995a, Fredrick and Moore 1991).

White-headed woodpeckers have also been found to use recently burned forest of ponderosa pine (Forristall et al. 2004, 2007, Kozma 2011, 2012, Kozma and Kroll 2012, Saab and Dudley 1998, Wightman et al. 2011). In south central Oregon, nest success was higher in burned habitats than unburned habitats (Forristal et al. 2004, Frenzel 2004).

Landscapes with a mosaic of open habitat for nesting in close proximity to closed-canopy forests which provide foraging habitat seem to be important for White-headed woodpeckers (Hollenbeck et al. 2011, Wightman et al. 2010, Latif et al. 2012). Closed-canopied forests with cone-producing pine trees and insects may be important for year-round foraging, particularly outside the breeding season (Garrett et al. 1996).

White-headed woodpeckers lack strong excavating ability and rarely forage on completely dead trees. They typically feed on insects during the spring and early summer by gleaning and pecking (Garrett et al. 1996). The woodpeckers switch to ponderosa pine or sugar pine (*Pinus lambertiana*) seeds from late summer through the winter (Bull 1980, Dixon 1995a, Ligon 1973).

The White-headed woodpecker is generally sedentary and usually occupies the same home range throughout the year and return to the same breeding site year after year; however, limited wandering may occur during the non-breeding season to exploit locally and temporarily available abundant food sources of pine seeds (Garrett et al. 1996).

Reported home range sizes (median 85% adaptive kernel) vary from 125 acres in central Oregon to 245 acres in central Washington (Dixon 1995a, Lorenz et al. 2012). Lorenz et al. (2011) found overlap in home ranges of neighboring pairs.

Threats to the Species

Habitat loss is the primary threat to White-headed woodpeckers (NatureServe 2008). Local population declines have occurred following loss of large open ponderosa pine forests from logging and catastrophic fire, and loss of open habitat due to fire suppression (Garrett et al. 1996, Marshal 2003).

Wightman et al. (2010) and Frenzel (2004) found that predation by small mammals was the most common cause of nest failure of White-headed woodpeckers. Increasing shrub cover may lead to increasing populations of small mammals (Smith and Maguire 2004). Nest success of White-headed woodpeckers is higher at nest sites with lower shrub cover (Frenzel 2004, Kozma and Kroll 2012).

Management Considerations

Restoring habitat for White-headed woodpeckers will be an important management strategy. Use of historical conditions can be used to inform restoration at multiple scales by providing insights into composition, structure and spatial patterns that supported low-severity fire regimes and associated wildlife species in the past (Churchill et al. 2013a, Harrod et al. 1999, Hessburg et al. 2005, Franklin and Johnson 2012, Spies et al. 2006, Youngblood et al. 2004). Managing for historic conditions is expected to provide for resilience, even in the face of climate change, because these forests persisted through past climatic fluctuation and multiple disturbance events (Larson and Churchill 2012, Youngblood et al. 2004).

Dry forest restoration treatments should help restore habitat for White-headed woodpeckers. Restoration treatments in ponderosa pine forests in the eastern Washington Cascades had a positive effect on White-headed woodpeckers (Gaines et al. 2007, 2010). The retention of the large trees and snags and opening up of the overstory canopy through restoration treatments were likely important to the positive response to treatment by White-headed woodpeckers (Gaines et al. 2007).

Based on habitat use by White-headed woodpeckers, restoration of their habitat should include:

- retaining and producing large, older ponderosa pine trees used for foraging;
- retaining and creating large snags used for nesting;
- reducing shrub cover and excess down wood to reduce numbers of small mammal which prey on nests;

- reducing canopy density across the landscape to provide interspersion of open and closed pine stands;
- maintaining within stand heterogeneity;
- reintroduction of rust-resistant white pine or sugar pine where appropriate would provide an alternative winter food source.

Dry forest restoration goals are compatible with fuels reduction treatments, but an ecological approach that incorporates restoration of spatial and temporal patterns of forest structure (large, old trees, snags, down wood) and composition in order to restore ecosystem processes and functions is important (Hessburg et al. 2007). Recommendations include not over simplifying by applying the same methods or prescriptions across the entire landscape, and additionally emphasizing restoration of natural ecological processes rather than specific stand conditions (Churchill et al. 2013a, Hessburg et al. 2005, Keeling et al. 2006).

Stands with the highest priority for restoration of White-headed woodpecker habitat are stands with large pine that are overstocked and at risk from uncharacteristic disturbance or drought stress. Mid-seral ponderosa pine stands (60-100 years old) are a secondary priority for restoration treatment, with the objective to release medium sized trees to develop larger, older trees and resilient stands (Brown et al. 2004).

Monitoring Strategy

A separate monitoring strategy has been developed for White-headed woodpeckers (Mellen-McLean et al. 2013). The strategy is designed to ensure consistent and scientifically credible sampling, data collection, and analysis protocols are used by the agencies in White-headed woodpecker inventorying and monitoring activities.

The strategy is a 3-pronged approach including:

- <u>Broad-scale occupancy and distribution monitoring -</u> The protocol is designed to provide reliable, standardized data on the distribution and site occupancy for White-headed woodpecker across their range in Oregon and Washington.
- <u>Effectiveness monitoring -</u> The protocol is designed to provide reliable, standardized data on the effectiveness of treatments to restore or enhance habitat for White-headed woodpecker, and the impacts of treatments with other objectives (e.g., fuels reduction, salvage logging) on White-headed woodpecker across their range in Oregon and Washington.
- <u>Validation monitoring -</u> HSI models, especially for burned habitat, need to be further validated for areas outside central and southeast Oregon, and refined and validated for Washington. New data on additional known White-headed woodpecker nesting locations in both burned and unburned landscapes are needed to accomplish model refinement and validation for other areas.

Introduction

Goal

The goal of this Conservation Assessment (CA) is to summarize existing knowledge on the White-headed woodpecker (*Picoides albolarvatus*). Included is information on biology, ecology, habitat use, and threats to the species. The CA identifies potentially important information gaps and uncertainties regarding the species. Management considerations are offered which may help agency personnel better manage populations and habitats. This document focuses on White-headed woodpecker habitats on public land.

Scope

The geographic scope of this assessment includes the historic, known and suspected range of the White-headed woodpecker in North America; however, the focus is on their range within Oregon and Washington. Management considerations focus on their habitats on public lands which are primarily, low-elevation, dry forests with a component of large ponderosa pine (*Pinus ponderosa*). In Oregon and Washington, the vast majority of habitat for the woodpecker is on Forest Service lands.

Management Status

Oregon Biodiversity Information Center, formerly Oregon Natural Heritage Program, ranks the White-headed woodpecker as S2S3 and has included them on their "List 2" which indicates they are "imperiled" and vulnerable to extirpation in Oregon. http://orbic.pdx.edu/documents/2010-rte-book.pdf

As of February 2008, Washington Natural Heritage Program ranks the woodpecker as S2S3 which indicates they are imperiled and vulnerable to extirpation in Washington http://www1.dnr.wa.gov/nhp/refdesk/lists/animal_ranks.html

Heritage programs in both Idaho and Nevada have the species ranked as S2, while in California the species is apparently secure and does not have a state rank. www.natureserve.org

In British Columbia, Canada the province rank is S1 indicating the White-headed woodpecker is "critically imperiled", making it especially susceptible to extirpation or extinction. http://wlapwww.gov.bc.ca/wld/documents/ranking.pdf

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) creates a national listing of species at risk that have been assessed through a formal status report review process. The woodpecker is listed as endangered under COSEWIC. http://www.cosewic.gc.ca/eng/sct0/rpt/rpt_csar_e.pdf

Oregon Department of Fish and Wildlife has ranked the White-headed woodpecker as "Critical"; species for which a listing as Threatened or Endangered would be appropriate if immediate conservation actions are not taken. http://www.dfw.state.or.us/wildlife/pdf/sensitive_species.pdf

Washington Department of Wildlife ranks the woodpecker as a “Candidate” species under review for listing as Endangered, Threatened or Sensitive.
http://wdfw.wa.gov/wlm/diversity/soc/candidat.htm

The U.S. Fish and Wildlife service lists the White-headed woodpecker as a species of conservation concern at the National level and at the regional levels of the Great Basin which includes the east cascades of Oregon and Washington and the Northern Rockies which includes the Blue Mountains of Oregon and Washington (USFWS 2008).

Partners in Flight (PIF) have identified the White-headed woodpecker as a Species of Regional Importance in Oregon and Washington, and state that conservation action is needed to reverse or stabilize long-term population declines or the species will be at risk of extirpation. The woodpecker is also a focal species in PIF’s conservation strategy for dry forest habitats (Altman 2000a, 2000b).

The White-headed woodpecker is listed as Sensitive on the BLM Special Status Species List (2012) and on the US Forest Service Region 6 Regional Forester’s Sensitive Species List (2012) for both Oregon and Washington.

Federal management for this species follows Region 6 Forest Service Sensitive Species policy and OR/WA BLM Special Status Species (SSS) policy. For OR/WA BLM administered lands, SSS policy details the need to manage for species conservation. For Region 6 Forest Service administered lands, the Sensitive Species policy requires the agency to maintain viable populations of all native and desired non-native wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest lands. Management “must not result in a loss of species viability or create significant trends toward federal listing” (FSM 2670.32) for any identified sensitive species.

Classification and Description

Systematic and Synonymy

The White-headed woodpecker is a member of the genus *Picoides.* It is probably closely related to the Hairy woodpecker (*Picoides villosus*), however, relationships within the genus are not well understood. Originally the species was placed in the genus *Leuconerpes* and the monotypic genus *Xenopicus*. It was later placed in the genus *Dendrocopos*. New World forms of *Dendrocopus* are now placed in the genus *Picoides* (Garrett et al. 1996).

Two subspecies are recognized. *P. a. albolarvatus* occurs through most of the species’ range. *P. a. gravirostris* occurs in southern California from the San Gabriel Mountains south to the southern edge of the species’ range (Garrett et al. 1996).

Species Description

From Garret et al. (1996) and Terres (1980):

> The White-headed woodpecker is a medium-small woodpecker: 8.4-9.2 inches, 55–65 g. It is the only North American woodpecker with a white head. It is also unique among *Picoides*

> in having entire body plumage and tail black, except for white on outer primaries forming a wing-patch visible on folded wing; additional white from primaries shows in flight. Males have a narrow red patch on the back of the head which is absent in females. In juvenile plumage, black is duller, variable vermilion patch on crown, white patches in remiges generally more broken. The woodpecker is unmistakable with its mostly white head. Within its range, only the much larger, crested Pileated woodpecker (*Dryocopus pileatus*) shares solid black dorsum and underparts. Acorn woodpecker (*Melanerpes formicivorus*) is sympatric with White-headed in portions of Oregon and California but generally occurs in more oak (*Quercus* sp.)-dominated habitats; shares large white primary-patch and black back, but is easily distinguished by mostly white underparts, white rump, black patch around eyes, and very different vocalizations.

Males and females differ in mean culmen length and body weight, with males being larger (23.6 mm and 62 grams) than females (21.5 mm and 58 grams) (Dixon 1995a).

The southern race of the White-headed woodpecker (*P. a. gravirostris*) has a larger bill than the northern race (*P. a. albolarvatus*) (Garrett et al. 1996). In the southern part of their range these woodpeckers use Coulter pine (*Pinus coulteri*) which has large, spiked cones (Ligon 1973).

Biology and Ecology

Life History

The following information on life history is from Garret et al. (1996) unless otherwise cited:

White-headed woodpeckers appear to be monogamous, maintaining pair bonds year round. The pair forage, drink and occasionally roost together. Mated pairs often call back and forth to each other throughout the day. Pair bonds are formed, reestablished or reinforced during early spring through drumming, calling, and male-female interactions.

White-headed woodpeckers are cavity nesting birds. Nest cavity excavation in Oregon begins around the beginning of May. Both sexes share in excavation duties. There may be many “false starts” resulting in partially excavated cavities that are not used for nesting. A new nest cavity is usually excavated each year; however, occasionally the pair will reuse a cavity excavated in a previous year. Old nest cavities are used as roosts.

The woodpeckers normally produce a single clutch per year beginning near the end of May. Clutch size is usually 4 or 5 eggs. Both members of the pair develop brood patches and share incubation of the eggs, with the male incubating at night. Incubation exchanges occur every 45-60 minutes. Incubation lasts about 14 days. Hatching is asynchronous and the last-laid egg often does not hatch.

Young are naked with eyes closed when they hatch. Pin feathers erupt by about day 12 and they are fully feathered by day 19. Both parents brood the young with the male brooding at night. The young are fed by both sexes. Feeding intervals begin at every 3-10 minutes for small young and lengthens to about 18 minutes prior to fledging. The adults enter the cavity to feed the young for the first 10 to 12 days, after which the adults partially enter the cavity to feed, and about 7 days prior to fledging the young are fed by adults from outside the cavity.

Young fledge from the nest about 26 days after hatching, usually in late June to early July. Typically, 1 to 3 young are fledged per successful nest per year. Adults coax nestlings to fledge by calling and drumming near the nest cavity. Adults feed young after fledging as long as late August in Oregon. The family group scatters somewhat after fledging with each adult attending 1 or 2 young. Young associate with their parents through autumn.

Activity Pattern and Movements

Dixon (1995) reports that White-headed woodpeckers spent 70% of their time foraging, 10% flying, 6% resting, 5% preening, and 2.3% drumming and calling.

The White-headed woodpecker is generally sedentary and usually occupies the same home range throughout the year and return to the same breeding site year after year (Garrett et al. 1996).

While White-headed woodpeckers are not migratory, limited wandering may occur during the non-breeding season to exploit locally and temporarily available abundant food sources of pine seeds (Garrett et al. 1996). Dixon (1995a) also noted adults and recently fledged young move up to 5 miles from the breeding territory to feed on spruce budworm (*Choristoneura occidentalis*) in central Oregon. In California, birds have been found wandering in lowland areas well outside their breeding range, up to 93 miles from the nearest breeding area (Garrett et al. 1996).

No information is available on dispersal of young from the natal site to their first breeding site. However, Lorenz et al. (2011, 2012) have banded young at nest sites which should allow collection of dispersal information in the near future.

Home Range Size

In the eastern Cascades of Oregon, Dixon (1995a, 1995b) reported summer home range sizes averaging 557 acres using minimum convex polygons (MCP) (n=30) and 187 acres (n=18) using the 85% adaptive kernel method. Annual home ranges of 10 birds averaged 165 acres for MCP and 403 acres for 85% kernel. Dixon (1995a) reported differences between study areas and amount of fragmentation in the landscape (Table 1.)

Table 1. Home range estimates from central Oregon (Dixon 1995a).

Type or location of landscape	Season	n	Median MCP	MCP range	Median 85% adaptive kernel	85% adaptive kernel range
Continuous	**Summer**	7	158 acres	37-314 acres	131 acres	72-235 acres
Fragmented	**Summer**	6	734 acres	116-2705 acres	156 acres	62-1018 acres
Continuous	**Fall**	5	188 acres	138-393 acres	114 acres	104-230 acres
Fragmented	**Fall**	2	301 acres	254-351 acres	163 acres	148-180 acres
Continuous	**Annual**	7	257 acres	165-403 acres	153 acres	114-212 acres
Fragmented	**Annual**	3	793 acres	141-1099 acres	225 acres	86-259 acres

Lorenz et al. (2011, 2012) in the southeastern Washington Cascades are currently studying White-headed woodpecker space use. Preliminary analysis of radio telemetry data indicates summer home range sizes in their study area are smaller than those in Dixon's (1995a, 1995b) study when using the MCP method, but similar when using the 85% adaptive kernel method (Table 2). During the breeding season (May through August) the mean 95% kernel home range size averaged 257 acres (104 ha) (Lorenz et al. 2012).

Table 2. Comparison of summer (July – October) home range sizes of White-headed woodpeckers from central Oregon and central Washington study areas.

Study	Median MCP	n	Median 85% adaptive kernel	n	Mean 95% fixed kernel	n	Study area
Dixon 1995a, 1995b	424 acres	30	125 acres	18			Central Oregon
Lorenz et al. 2011	94 acres	9	138 acres	9	180 acres	9	Central Washington
Lorenz et al. 2012	138 acres	9	245 acres	9	200 acres	9	Central Washington

Lorenz et al. (2011) found overlap in home ranges of neighboring pairs. After young fledged in July, many of their radio-marked birds shifted their activities away from the nest site, up to 1148 ft away from the nest snag.

Food Habits

White-headed woodpeckers lack strong excavating ability and rarely forage on completely dead trees. In northeast Oregon, Bull (1980) observed the birds feeding on live trees 80% of the time; they spent 41% of their foraging time extracting seed from ponderosa pine cones. Similarly, in Idaho Ligon (1973) observed the birds foraging on live trees 91% of the time with only 8% of their foraging time spent on snags. In the Sierra Nevada, Raphael and White (1984) found White-headed woodpeckers foraged on live trees 71% of the time, followed by snags and logs 28% and 2% of the time respectively.

In contrast, Lorenz et al. (2012) found White-headed woodpeckers in central Washington foraging primarily on wood-boring beetle larvae in dead wood during the excavation, incubation, and nestling period. The dead wood used was 96% stumps left from past timber harvest. The woodpeckers switched to gleaning caterpillars from foliage during the fledgling period, and then to ponderosa pine trunks during the autumn. Use of pine cones was rare during 2012, a year of low cone production in the study area.

Dixon (1995a) reports that foraging behavior was 35% gleaning, 31% cone feeding, 24% pecking, 7% sapsucking, and 3% other behaviors. Raphael and White (1984) observed the woodpeckers' behavior as 85% gleaning, 12% drilling, and 4% sapsucking.

In Idaho, White-headed woodpeckers feed primarily on insects from about May to September (Blair and Servheen 1995). Young are fed mainly insects including adult and larval ants, beetles, and cicadas (Garrett et al. 1996). Dixon (1995a) observed the birds heavily feeding on cicadas during the nesting period.

White-headed woodpeckers initiate nesting later than other woodpeckers. Kozma (2009) speculated that this is because they rely on insects that are found on the outside of the bark of trees rather than drilling into wood to feed. These insects likely become more active later in the spring when ambient temperatures are warmer.

The woodpeckers switch to ponderosa pine or sugar pine (*Pinus lambertiana*) seeds from late summer through the winter in Idaho (Blair and Servheen 1995). Ligon (1973) found 70-90% of stomach contents during late winter were pine seeds. Dixon (1995a) also found the woodpeckers foraging heavily on ponderosa pine seeds from August through January in central Oregon. Bull (1980) observed most of the seed harvesting occurred from September to February in northeast Oregon.

During August in Idaho, Ligon (1973) found female White-headed woodpeckers foraging in a bark beetle-infested area; however, their stomach contents contained 60-70% pine seeds and no beetles. Stomach contents of Hairy woodpeckers and male White-headed woodpeckers foraging in the same area contained 100% bark beetles.

In Idaho, Blair and Servheen (1995) report White-headed woodpeckers foraging on great mullein (*Verbascum thapsus*).

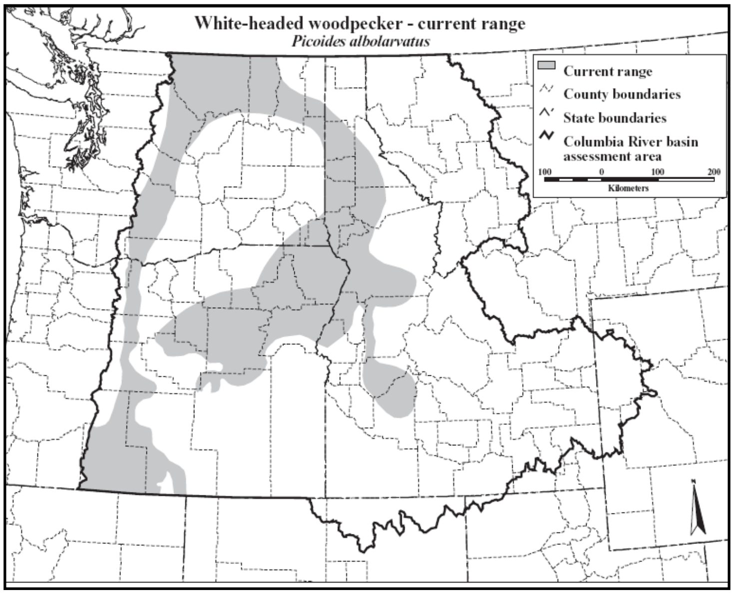
White-headed woodpeckers will sapsuck from small diameter trees, especially in early spring (Blair and Servheen 1995). Early spring may be a time of the year when pine seeds are depleted and abundances of insects are low relative to later in the spring and summer (Kozma 2010). Dixon (1995a) found the woodpeckers drilling their own sap wells, usually in close proximity to the nest tree. Kozma (2010) has also observed extensive sap feeding in the early spring in south-central Washington.

White-headed woodpeckers frequently drink from puddles, pools, streams and melted snow (Garrett et al. 1996). Ligon (1973) hypothesized that frequent drinking was likely due to a diet with a high proportion of dry vegetable matter.

Range, Distribution, and Abundance

White-headed woodpeckers are residents from south-central British Columbia, north-central Washington and northern and western Idaho south through eastern and southwest Oregon to southern California and west-central Nevada (AOU 1983, Garrett et al. 1996) (Figures 1 and 2). In Oregon and Washington they usually occur at elevations of 2800 - 5250 feet during nesting season, but may descend to lower elevations during winter (Garrett et al. 1996).

Figure 1. Distribution of White-headed woodpeckers from Garrett et al. (1996)



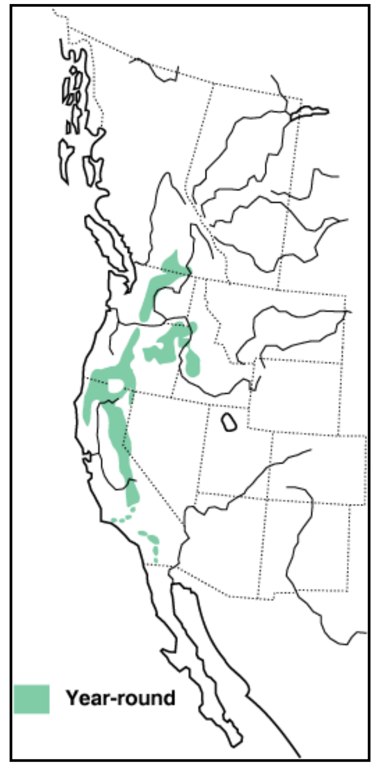


Figure 2. Distribution of White-headed woodpeckers in the Columbia River Basin from Marcot et al. (2003)

The White-headed woodpecker is an uncommon or rare resident in eastern Washington (Buchanan et al. 2003, Garrett et al. 1996). In Oregon it is an uncommon resident in the Ochoco, Blue, and Wallowa Mountains and on the east slope of the Cascades; it is locally distributed in southwest Oregon in the Umpqua River basin and the Siskiyou Mountains (Marshall 2003).

White-headed woodpeckers are considered very rare in southern British Columbia, with a population estimated to be under 100 birds (Cannings 1995). They are scarce and locally distributed in western Idaho, and are vagrants in the panhandle of Idaho (Blair and Servheen 1995).
In California and Nevada, the White-headed woodpecker is common in appropriate habitats of the Sierra Nevada and mountains of southern California (Garrett et al. 1996).

Density estimates from several sources are variable:

- Central and south-central Oregon: 0.00 – 2.53 birds/100 acres (Dixon 1995a) and 0.00 – 1.97 birds/100 acres [40 ha] (Frenzel and Popper 1998)
- Northeastern Oregon: 0.5 – 1.0 birds/100 acres (Mannan and Meslow 1984)

- Sierra Nevada Mountains: 1.2 pairs/100 acres based on spot-map surveys, and an average of 2.3 pairs/100 acres (range 0.1-5.0) based on Breeding Bird Censuses (Raphael and White 1984)

Population Trends

North American Breeding Bird Survey (BBS) trend data are the only systematically collected, range-wide trend data found for this species. BBS data for 1966 to 2010 indicate that the species has been increasing, with a trend of 1.1 percent per year (N=115 routes), across the western region (range-wide for this species) (Sauer et al. 2011). For Oregon the trend estimate was 1.9 percent per year based on 28 routes, but the trend was not significant. In Washington the trend estimate was 2.1 percent per year which was not significant, and based on only 9 routes. The "credibility measure" for this species is either red or yellow indicating results are "very imprecise" due to "very low abundance" of birds, low numbers of routes (9 and 28 respectively), or both; the results are so imprecise that a 5% or 3% per year change, respectively, would not be detected over the long-term (Sauer et al. 2011).

The positive trend indicated by BBS data is not supported by local information. Local population declines have occurred following loss of large open ponderosa pine forests from logging and catastrophic fire, and loss of open habitat due to fire suppression.

- In central Oregon, Dixon (1995a) estimated a high density of birds at 2.53/100 acres based on surveys in 1991 and 1993. By 1997 and 1998, Frenzel and Popper (1998) estimated a high density of birds at only 1.97/100 acres, using the same methods and study area as Dixon (1995a). This equates to over a 20% decline in high density estimates over about 5 years on this study area. Frenzel (2004) found that occupancy of known territories on the study area declined steadily from 1998 through 2002. In addition, Frenzel (2004) reported that the fledging rate was not adequate to offset estimated adult mortality rate in this population of White-headed woodpeckers unless juvenile survival rate was higher than adult survival rate, and juvenile survival rates are usually about 50% of adult survival rates.
- Analysis during the Interior Columbia Basin Ecosystem Management Project (ICBEMP) indicated that the White-headed woodpecker was one of 8 species (of the 97 species analyzed) that showed strong declines in habitat (>60% decline from historical conditions) (Wisdom et al. 2000).
- Today White-headed woodpeckers no longer occur at some sites in the Blue Mountains where they used to be relatively common; research in the late 1970s and early 1980s found the birds to be relatively common, whereas research conducted in the early 2000s in the same area found no White-headed woodpeckers (Altman 2000b, Bull 1980, Nielsen-Pincus 2005).
- In British Columbia, Cannings (1995) reports that White-headed woodpecker populations declined drastically in the 1970s, and by 1990 searches failed to locate any birds.

Demography

Species Demographics

No information is available on age at first breeding or life span (Garrett et al. 1996).

A few studies have looked at reproductive success. In 1991 nest success (at least 1 young fledged) in central Oregon was 83% (n=41) and 87.5% (n=16) in south central Oregon (Garrett et al. 1996). Nest success on the same study areas from 1997-2004 had dropped to a low of 23% and a high of 64% (Frenzel 2004). In south-central Washington, Kozma (2009) found nest success of 84.6% (n=22) during the period of 2003-2007, and Kozma and Kroll (2012) found nest success of 70% (0.70 survival rate) during the period 2005-2010. In the same area, Lorenz et al. (2011, 2012) reported nest success of 68% (n=28) for the 2011 breeding season and 79% (n=23) nest success during 2012. In post-fire habitat in south eastern Oregon nest success averaged 85% (n=20) during 2003 and 2004 (Forristal et al. 2004).

Egg success for White-headed woodpeckers in south-central Washington was 55% from 2003-2007 (Kozma 2009) and 50% for the period of 2005-2010, lower than egg success for either Hairy woodpeckers or Northern flickers (*Colaptes auratus*) (Kozma and Kroll 2012).

Frenzel (2004) estimated average adult survivorship of White-headed woodpeckers from 1997 through 2004 to be 0.65, ranging from 0.50 to 0.74. The estimate was based on turnover of color-marked birds on his study area in central Oregon. Using the same methodology, Lorenz et al. (2012) estimated survivorship of 0.77 (n=29) in south-central Washington; based on tracking radio-marked birds in 2011 and 2012 survivorship was estimated at 0.83. Mortality occurring between January and April would not be measured by the telemetry approach, a time of year when mortality could be high.

Limiting factors to population growth

A combination of low nest success and low adult survival rates appear to be limiting populations in central Oregon. Based on banded birds, Frenzel (2004) estimated adult survival over 6 years to be only 0.652. During the same period, nest success was only 45.2%, and fledglings per successful nest were 2.3. Based on these demographic rates, a juvenile survival rate of 0.66 would be required to offset the estimated adult mortality. The juvenile survival rate was unknown, but is often assumed to be 50% of adult survival rates (see Frenzel 2004). In addition, occupancy of known territories declined on all of Frenzel’s (2004) study areas over the 6-year study.

Relationship to broader species range

White-headed woodpeckers reach their greatest abundance in areas where there is more than one species of large-seeded pine present, which may increase the availability and reliability of seed crops (Garrett et al. 1996). The woodpeckers are most common in the Sierra Nevada, where ponderosa, Jeffrey pine (*Pinus jeffreyi*) and sugar pine, all large-seeded pines, often occur in close proximity (Garrett et al. 1996).

Sources, sinks, metapopulation dynamics

Kozma and Kroll (2012) calculated the source/sink status of White-headed woodpeckers on their study area in south-central Washington. The calculation compared the estimated number of female fledglings per female per year (FFFY) needed to offset mortality (Saab and Vierling 2001). Their analysis suggested that the heavily managed stands in their study area may be functioning as population sinks for White-headed woodpeckers.

Frenzel (2004) found most White-headed woodpecker nest sites in his study area in previously harvested stands. These harvested sites may mimic open pine-habitat, and thus attract the woodpeckers to nest in these stands. Nests in harvested stands tended to occur in relatively smaller diameter snags or stumps. Nest success in harvested units was depressed as compared to stands with higher densities of large trees and thus could be considered population sinks.

Habitat

General Habitat Description

White-headed woodpeckers are associated with coniferous forests dominated by pines. Tree species composition varies by geographic area, but large, mature pines are a required habitat component throughout the woodpecker's range (Garrett et al. 1996). Preferred habitat is relatively open forests with sparse understory vegetation.

In Oregon and Washington, White-headed woodpeckers occur primarily in open ponderosa pine or dry mixed-conifer forests dominated by ponderosa pine (Bull et al. 1986, Dixon 1995a, Frenzel 2004, Buchanan et al. 2003). A small population does occur in true firs in the Siskiyou Mountains of southwestern Oregon (Marshall 2003).

Dixon (1995a) concluded that White-headed woodpeckers in central Oregon selected for old-growth ponderosa pine stands at the scale of the home range. Her conclusions were based on radio-telemetry data for 18 adult birds. Home ranges were smaller when the home ranges contained more old-growth as compared to home ranges that were a mosaic of age classes. She defined old-growth as stands with 10 trees per acre greater than 21 inches dbh, or 2 trees per acre greater than 32 inches dbh. Based on telemetry locations, White-headed woodpeckers preferred to use areas with trees > 18 inches dbh.

In the same area as Dixon's study, Frenzel and Popper (1998) found highest densities of White-headed woodpeckers on sites that contained extensive amounts of old-growth interspersed with various silvicultural treatments. However, they found low densities of the birds in areas that were mostly old-growth ponderosa pine. They also found moderate densities of White-headed woodpeckers in dry mixed conifer forests which were dominated by firs but contained both ponderosa pine and sugar pine.

In central Oregon, Bate (1995) located White-headed woodpeckers in ponderosa pine habitats with moderate or light harvest; none were located in intensively harvested areas. Dixon (1995a) found no difference in use of partial cut, seed tree cut, or uncut stands and concluded seed tree and partial cut stands provided foraging habitat.

In Idaho, Fredrick and Moore (1991) surveyed for White-headed woodpeckers on transects across a variety of habitats. All observations of the woodpeckers were in mature and old stands of mixed ponderosa pine and Douglas-fir (*Pseudotsuga menziesii*) with open canopies and relatively low density of trees. They did observe birds foraging in mature mixed ponderosa pine and Douglas-fir that had been partially cut.

White-headed woodpeckers have been found using heavily managed stands in the Sun Pass State Forest in south-central Oregon (Lindstrand and Humes (2009) and in south-central Washington (Kozma 2011). The Sun Pass study area was characterized by early to mid-seral ponderosa pine forests that had been managed primarily by selection harvest, though remnant large trees did exist at low densities. In the Washington study area all stands had a history of timber management including burning and salvage logging, resulting in low densities of large ponderosa pine (> 51cm dbh). However, a source/sink analysis indicated that these managed habitats may be population sinks (Kozma and Kroll 2012).

White-headed woodpeckers were found using recently burned ponderosa pine forest on the Fremont National Forest (Toolbox and Silver fires) (Wightman et al. 2010, Forristal et al. 2004, 2007). The woodpeckers have also been found to use burned forests in eastern Washington (Kozma 2011, 2012, Kozma and Kroll 2012) and Idaho (Saab and Dudley 1998). In the Sierra Nevada, Raphael and White (1984) found the woodpeckers used burned habitat > 60% of the time, and Hanson and North (2008) observed the highest foraging presence of these birds in unburned and moderate severity, unlogged burns.

In the Sierra Nevada of California, White-headed woodpeckers are common in stands of ponderosa and sugar pine with components of Douglas-fir, white fir (*Abies concolor*) and red fir (*Abies magnificia*) (Garrett et al. 1996). Populations are locally abundant in burned areas or harvested forest where residual large-diameter live and dead pines are present (Raphael and White 1984, Raphael and Morrison 1987).

A preliminary analysis of the vegetation data collected from broad-scale occupancy monitoring from 2010-2012 was conducted (Mellen-McLean and Saab 2013) (Table 3). The analysis used descriptive statistics and t-tests to compare tree and snag densities between occupied points (n=66) and unoccupied points (n=231). Mean density of smaller trees 10-20 in dbh was less at occupied points than unoccupied points (P=0.005), and mean density of large trees (≥20 in dbh) was higher at occupied points than unoccupied points (P=0.08). These findings are consistent with previous findings on White-headed woodpecker habitat use. Density of smaller snags (10-20 in dbh) was less at occupied points than unoccupied points (P=0.09). Densities of larger snags (≥20 in dbh) were not significantly different between occupied points and unoccupied points (P=0.26).

Table 3. Tree and snag densities at occupied and unoccupied survey points in Oregon and Washington (Mellen-McLean and Saab 2013.

	Large tree density (>20 in dbh)	**Small tree density (10-20 in dbh)**	**Large snag density (>20 in dbh)**	**Small snag density (10-20 in dbh)**
Occupied points n=66	10.1/acre	38.3/acre	1.1/acre	2.5/acre
Unoccupied points n=231	8.6/acre	50.1/acre	0.95/acre	3.1/acre

Nesting Habitat

<u>Nest stands</u>

Buchanan et al. (2003) compared 21 nest sites of White-headed woodpeckers to random sites in the eastern Cascades of Washington. They found that nest sites were in open ponderosa pine forests and contained a greater number, size and basal area of large trees and snags than random sites. Nest sites were generally located on slopes of < 20% (mean 10.4%), and they tended to be on lower slopes than other topographic positions. The vast majority of nests were below 4000 feet [1219 meters] in elevation.

Kozma (2009, 2011, 2012) and Kozma and Kroll (2012) studied White-headed woodpeckers in eastern Washington in an area dominated by managed stands. These stands had recently been harvested through uneven-age management, or had been burned with subsequent salvage logging. The stands surrounding nest sites were young with relatively lower density of large trees than other studies (Table 4). The White-headed woodpeckers in this study fledged fewer young than Hairy woodpeckers in the same study area. Kozma and Kroll (2012) speculated that the smaller diameter trees provided suboptimal habitat resulting in food limitation and decreased nestling feeding rates.

Bull (1980) found 4 White-headed woodpeckers nesting in ponderosa pine forests in northeast Oregon. Her nest site had higher canopy closure and tree densities than other studies in Oregon and Washington (Table 4).

Nest sites are not necessarily representative of overall habitat needs; nest sites tend to have more open canopies compared to foraging and roosting sites (Marshall 2003, Dixon 1995a). In central Oregon, nest sites were often in stands that had sustained harvest that had opened up the canopy such as partial cuts, clear cuts and shelterwoods (Dixon 1995a, Frenzel 2004). In south-central Oregon, nesting White-headed woodpeckers were found in burned areas where pre-fire canopy cover was relatively open (<40%) (Wightman et al. 2010).

Frenzel (2004) noted that White-headed woodpeckers were attracted to areas with openings created by silvicultural treatments, often nesting in stumps when snags were not available. However, nesting success was low at these sites. Nest sites that were in uncut stands or stands with at least 12 large (>21 inches dbh) trees per acre had significantly higher nest survival than nests in harvested sites with fewer large trees.

Hollenbeck et al. (2011) developed a habitat suitability index (HSI) model for unburned forests of central Oregon using remotely-sensed data and a Mahalanobis modeling technique. Suitable nesting sites for White-headed woodpeckers occurred at low elevations, in areas with low slope, and sites with high density of large trees (trees ≥20 in dbh/acre) and larger QMD (quadratic mean diameter).

Validation monitoring of the Hollenbeck et al. (2011) model resulted in re-calibrated HSI models (Latif et al. in prep). The new models are based on 2 different modeling methods, a Mahalanobis model and a Maxent model. Important variables identified by one or both models included areas with lower slope, lower percent canopy cover, and higher density of large live trees (> 20 in dbh) than the landscape as a whole.

Wightman et al. (2010) assessed habitat at 38 White-headed woodpecker nest sites in recently burned ponderosa pine forest in south-central Oregon. They found that pre-fire canopy cover of nest sites (2.5 acre around nest) averaged 29%. In the same study area, Forristal et al. (2004) found snag densities at nest sites averaged 29.3 snags/acre > 9 inches dbh (Table 4).

Nest sites in Oregon and Washington occur primarily on flat topography with average slope < 10 percent (Table 4). In Idaho, Fredrick and Moore (1991) found nest sites on steeper slopes, ranging from 17% to 41% slope. In the Sierra Nevada, Milne and Hejl (1989) also report nest sites on steeper slopes, averaging 17% slope.

Table 4. Characteristics of White-headed woodpecker nest stands in Oregon and Washington.

	Kozma 2012 burned & unburned	**Frenzel 2004**	**Dixon 1995a**	**Buchanan et al. 2003**	**Bull 1980**	**Forristal et al. 2007**
Study location	south-central Washington	central and south-central Oregon	central and south-central Oregon	eastern Cascades Washington	northeast Oregon	south-central Oregon
Snag density	15/acre & 5/acre >10 in. dbh	4/acre > 6 in. dbh	1.9/acre >10 in. dbh	3.5/acre > 4 in. dbh	36/acre >4 in. dbh	29.3/acre (se = 8.5) >9 in. dbh
Large snag density >20 in dbh		1.5/acre				
Tree density	5/acre & 28/acre >10 in. dbh	48/acre > 5 in; 25/acre > 9 in.		11/acre > 4 in. dbh	132/acre >4 in. dbh	
Large tree density > 20 in dbh		6.1 trees/acre	3 trees/acre	5.0 trees /acre		
Average stand dbh			14.6 in. dbh			
Canopy cover %	36% & 52%	11%	41%	7%	56%	
Shrub cover %	15% & 18%	11%		28%		
Slope %	21% & 18%	8%	9%	10.4%	10%	
Sample size (nest stands)	24 & 50	405	43	20	4	40

In Sierra Nevada, Milne and Hejl (1989) found that White-headed woodpeckers nested in open-canopied stands of mature and “overmature” trees. Raphael and White (1984) assessed nest stands using discriminant functional analysis; White-headed woodpecker nest sites were about the middle of a discriminant function of shrub cover, live tree basal area, large snag density and at the low end of a discriminant function of canopy height, live tree basal area, and proportion unburned. This translates to White-headed woodpecker preferred nest sites with moderate shrub cover and large snag density, and low tree density, but larger trees. They also tended to use areas with a higher proportion of burned forest.

Nest trees:
White-headed woodpeckers typically excavate nest cavities in snags; however, they also use stumps, logs, rootwads, dead tops of live trees, and buildings (Marshall 2003, Frenzel 2004).

Nest trees of White-headed woodpeckers are typically large, moderately decayed, ponderosa pine snags (Table 5). In Oregon and Washington, 6 separate studies indicate average nest tree dbh of 15 to 40 inches dbh. Nests are relatively close to the ground with average nest heights across studies of less than 6 meters. Nest characteristics are similar from 4 studies outside of Oregon and Washington, with the exception of the Sierra Nevada, where Jeffrey pine, red fir, white fir and sugar pine are the preferred species used for nest cavities (Table 5).

Table 5. Nest tree characteristics of White-headed woodpeckers in Oregon and Washington.

	Kozma 2012 burned & unburned	**Frenzel 2004**	**Dixon 1995a**	**Buchanan et al. 2003**	**Bull 1980**	**Cannon 2011**
Nest dbh (in)	16.9 & 15.0	27.1	25.6	20.3	17.7	39.4
Nest height (ft)	44.3 & 27.9	11.8	16.4	19.0	9.8	7.2
Decay	moderate to decayed	71% moderate		moderate to hard		soft
Broken top %	61%		77%	43%	49%	100%
Tree species	80.6 % ponderosa pine	ponderosa pine	84% ponderosa pine	76% ponderosa pine	75% ponderosa pine	Douglas-fir
Sample size	77	405	43	21	4	1
Study location	south-central Washington	central and south-central Oregon	central and south-central Oregon	eastern Cascades Washington	northeast Oregon	southwest Oregon

Table 6. Nest tree characteristics of White-headed woodpeckers in areas outside Oregon and Washington.

	Saab et al. 2002	Fredrick and Moore 1991	Milne and Hejl 1989	Raphael and White 1984
Nest dbh (in)	16.7	22.0	31.5	25.4
Nest height (ft)	23.3	9.2	9.8	6.6
Decay			moderate and soft	soft
Broken top %		67%	66%	
Tree species		ponderosa pine	Jeffrey pine, white fir, red fir, sugar pine	red fir, Jeffrey pine
Sample size	14	6	53	11
Study location	west-central Idaho	west-central Idaho	Sierra Nevada	Sierra Nevada

Roosting Habitat
Dixon (1995a) is the only study of roosting habitat. She located 110 roosts, all in ponderosa pine habitat types. Most roosts were in multi-layered stands with higher canopy closure, averaging 57%, than nest sites (Table 4). Density of large live trees (>21 inches dbh) was also higher at roost sites, averaging 15.7/acre, than at nest sites (Table 4). Most roosts were in partially cut (54%) or uncut (36%) stands.

Most roost trees were dead ponderosa pine (58%), but many were in live ponderosa pine (33%). The rest of the roosts were in quaking aspen snags and 1 live quaking aspen. Roost snags tended to be in a more advanced state of decay than nest snags. Roost tree diameter ranged from 8-46 inches averaging 24.4 inches.

Foraging Habitat
Dixon (1995a) reports that White-headed woodpeckers spent most of their foraging time in ponderosa pine types (92%), and they foraged primarily in ponderosa pine trees (98%). Mean dbh of foraging trees was 27 inches dbh. Foraging stands averaged 65% canopy closure.

Dixon (1995a) found sap feeding occurred in small dense stands of pole-sized trees (5-9 inches dbh). Kozma (2010) also found that White-headed woodpeckers used smaller diameter ponderosa pine for sap feeding. The smaller trees have thinner bark which makes drilling wells easier.

Bull (1980) also found the woodpeckers foraged almost exclusively in ponderosa pine and ponderosa pine/Douglas-fir habitat types, and they foraged exclusively on ponderosa pine with an average dbh of 17 inches dbh (n=142).

In central Washington, Lorenz et al. (2011) found White-headed woodpeckers foraging on species other than ponderosa pine 25% of the time. Other species included Douglas-fir, grand fir, and western larch. The average diameter of trees used for foraging was 20.5 inches.

In Idaho Fredrick and Moore (1991) found the birds foraged on large diameter live ponderosa pine trees. Foraging trees were larger than average tree in the stand with a mean dbh of 28 inches.

In the Sierra Nevada, Raphael and White (1984) reported White-headed woodpeckers foraging activity was primarily on Jeffery pine (49%), and secondarily on white fir (24%) or red fir (20%). The average tree diameter or foraging trees was about 15 inches dbh.

Frenzel (2004) speculated that at higher elevations in Oregon, a second species of large-coned pine, in addition to ponderosa pine, may be an important component of foraging habitat. During years when ponderosa pine has a poor cone crop the alternate species (e.g., sugar pine) may provide a fall and winter food source. In California, the birds are not common in pure stands of ponderosa pine, but are common in stands with two or more species of large-coned pines (Garrett et al. 1996). Dixon (1995a) reported that White-headed woodpeckers traveled 6.2 – 8.1 mi. outside their usual territories to forage on sugar pine seeds.

Landscape Scale Habitat

Several researchers report White-headed woodpeckers use relatively open landscapes. In Wightman and Saab's (2008) southeastern Oregon study area 71% of the landscape consists of open stands with canopy cover < 40%. In Kozma's (pers. comm.) east-central Washington study area the landscape consists primarily of open managed stands.

Dixon (1995a) found that White-headed woodpecker density was linearly correlated with the amount of old-growth ponderosa pine habitat on the landscape. The birds would travel across younger stands to access the old-growth habitat. In the same central Oregon study area, Bate (1995) found higher densities of White-headed woodpeckers on landscapes with more large trees (>20 inches dbh) and more pine snags larger than 8 inches dbh. The highest density of woodpeckers was found on the Black Butte study area which averaged 10-15 large trees per acre; the second highest density of the birds was on the Metolius study area which averaged 20 large trees per acre.

Landscapes with a mosaic of open habitat for nesting in close proximity to closed-canopy forests which provide foraging habitat seem to be important for White-headed woodpeckers (Hollenbeck et al. 2011). Closed-canopied forests with cone-producing pine trees and insects may be important for year-round foraging, particularly outside the breeding season (Garrett et al. 1996).

Habitat Suitability Index Models

Rocky Mountain Research Station (RMRS) has developed habitat suitability index (HSI) models for nesting White-headed woodpeckers in eastern Oregon. Two types of models exist; an HSI for post-fire habitats and separate HSI models for unburned forest habitats. These models are continually being validated and updated as new data become available. Below is the current status of the models. Annual reports will include updates on the HSIs as they are refined. Table 7 compares the HSI models.

The HSI models used field-collected plot data and/or remotely-sensed data. Field-collected variables were related to nest snag characteristics and tree density at the 2.5 acre scale. Environmental variables describing topography and forest structure at both the nest site (2.5 acre) and the landscape scale (776 acres) were generated using remotely-sensed data (GNN; Landscape

Ecology, Modeling, Mapping, and Analysis (LEMMA 2006)). Landscape metrics, edge density or interspersion/juxtaposition index, were used to represent a quantitative measurement of the mosaic of different patch types (FRAGSTATS; McGarigal and Marks 1985).

Partitioned Mahalanobis distance (D^2) and/or MaxEnt (Maximum Entropy) modeling techniques were used to develop the HSI models. Both techniques perform well with presence-only data.

Table 7. Habitat Suitability Index (HSI) Models for White-headed woodpecker nesting habitat developed by RMRS.

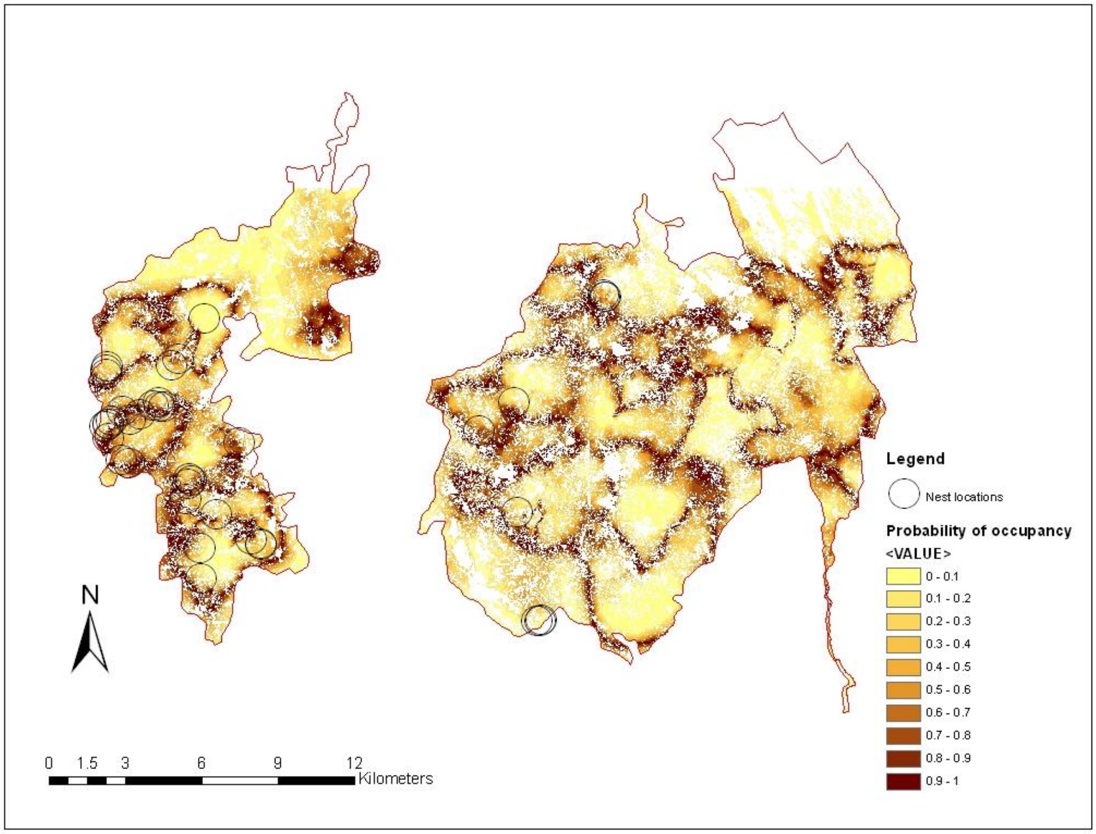
Model Citation	**Habitat Type**	**Geographic Area**	**Model type**
Wightman et al. 2010	Burned forest	SE Oregon	Mahalanobis
Hollenbeck et al. 2011	Unburned forest	Central & SE Oregon	Mahalanobis
Latif et al. 2012	Unburned forest	Central & SE Oregon	Mahalanobis and Maxent
Latif et al. in prep	Unburned forest	Eastern Oregon	Maxent

Wightman et al. (2010) developed an HSI using the Mahalanobis technique for post-fire habitat in southeast Oregon (Figure 3). The model's landscape scale variables of pre-fire canopy cover and quadratic mean diameter of trees were acquired from GNN data (LEMMA 2006). Post-fire data from US Forest Service Remote Sensing Applications Center (RSAC) were used to calculate normalized burn ratio (NBR) as an index of fire severity. Nest-site scale data were collect at nest sites and random points.

White-headed woodpecker habitat at the landscape scale was characterized as approximately 62% of the landscape in low severity or unburned forest, with moderate to high severity burn patches intermixed. Pre-fire, approximately 70% of the landscape had open (<40%) canopy cover. Thus, White-headed woodpeckers nested within burned forest, if the fire pattern produced a mosaic of burn patch severities. At the 2.5 acre scale, the probability that a site was selected for nesting increased as the number of live trees decreased and as the decay class and dbh of the nest tree or snag increased.

Validation of the model is currently underway. The model is available on request from RMRS.

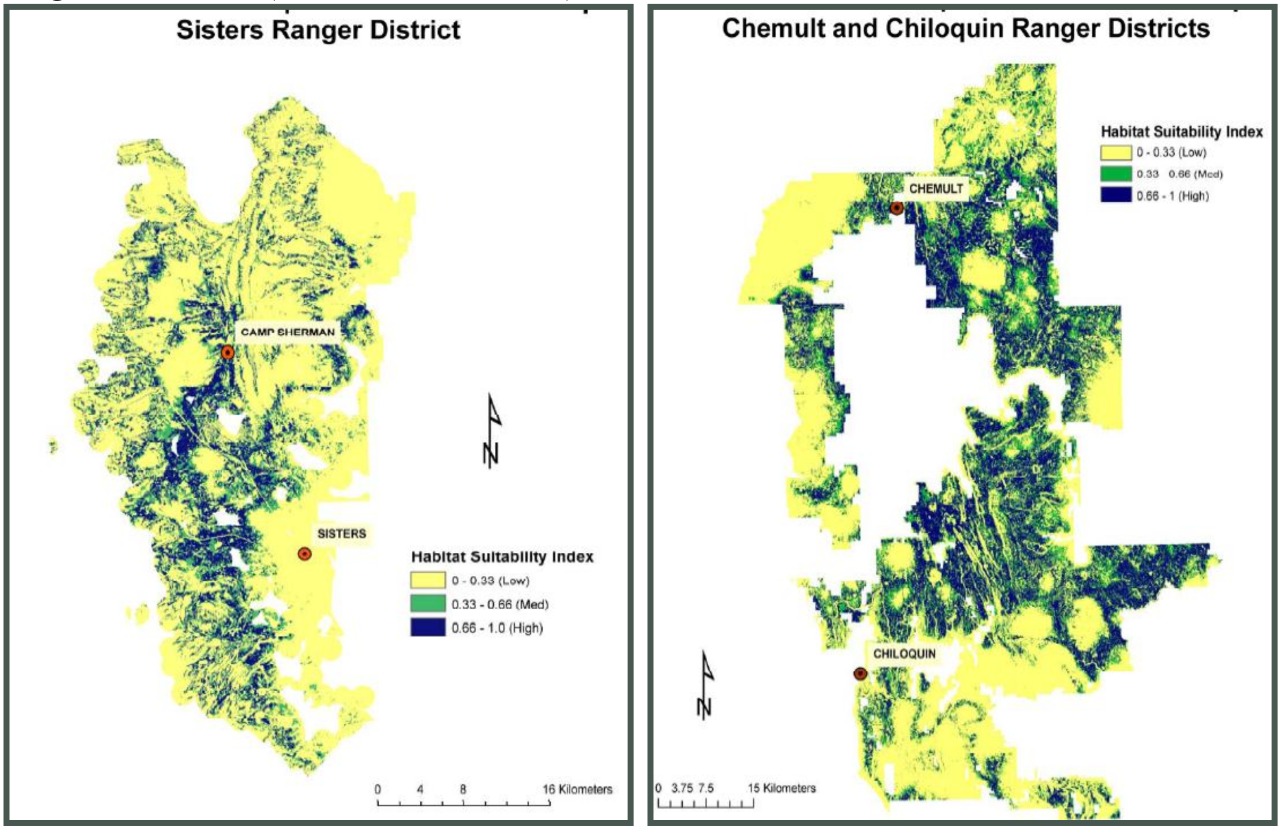
Figure 3. HSI model for White-headed woodpeckers on the Toolbox and Silver fires, Fremont-Winema National Forests, Oregon, USA, 2003–2007 (Wightman et al. (2010).



Hollenbeck et al. (2011) used the Mahalanobis technique to develop an HSI model for unburned forests of central and southeast Oregon (Figure 4). The model used data on 382 nest sites located in the Oregon East Cascades from 1997 to 2004 (Frenzel 2004). Variables for the HSI model were derived from remotely-sensed GNN data for both the landscape and nest site scales. A separate nest survival model used both remotely-sensed data and field-collected data.

The HSI results suggest nests of White-headed woodpeckers occur in landscapes with a high interspersion-juxtaposition of patches of ponderosa pine with low- and high-canopy cover. Lower elevations and lower slopes, relative to the regional landscape were important model components. High densities of large trees were also important components in the habitat suitability model.

Figure 4. HSI map for nesting White-headed woodpeckers on Sisters Ranger District, Deschutes National Forest, and Chemult and Chiloquin Ranger Districts, Fremont-Winema National Forest, Oregon, 1997–2004 (Hollenbeck et al. 2011).



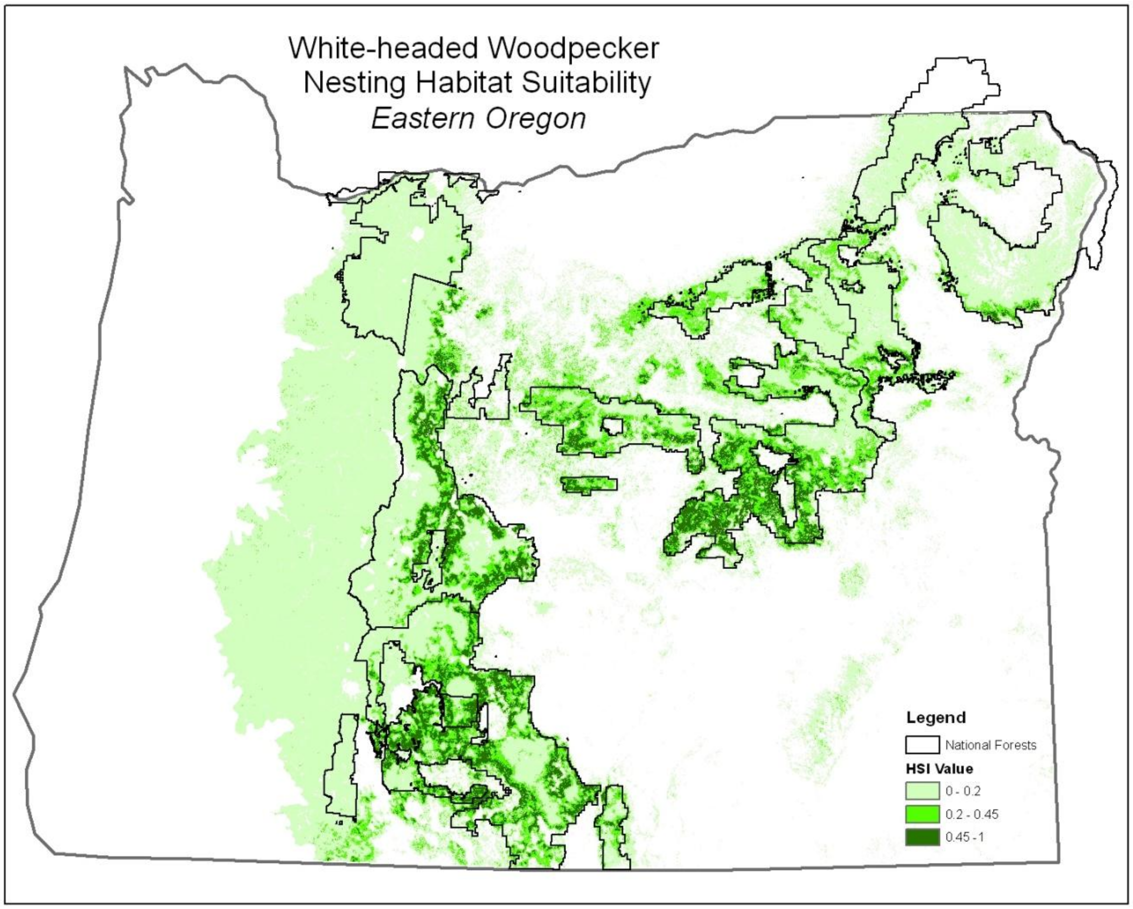
New HSI models developed by RMRS include additional nest sites located during 2010 and 2011. Both Mahalanobis and Maxent modeling techniques were used for the new models (Latif et al. 2012, in prep). Both HSI models relied on remotely sensed data.

The models were validated using presence/absence data collected on transects from Regional Broad-Scale Monitoring at a broader spatial extent than nest locations (both East Cascades and Blue Mountains, Oregon) (Latif et al. in prep). Point-level and transect-level presence/absence data were used in the validation.

The Maxent HSI model out-performed the Mahalanobis HSI model in terms of predicting nest locations and presence-absence based on point count surveys. The Maxent HSI model also correlated well with presence-absence data from the Blue Mountains which is outside the area where the data used to develop the model were collected (i.e., East Cascades).

A Maxent threshold value of 0.45 maximized the sum of sensitivity and specificity, or how well the model characterized nest locations as suitable while also characterizing a substantial portion of the landscape as unsuitable. This threshold thus best classifies suitable versus unsuitable habitat (Figure 5).

Figure 5. Mapped HSI scores from the Maxent model. The western Cascade Mountains and areas classified as non-forest in GNN data were not modeled (white areas). HSI classes were mapped with bounds to show areas classified as suitable, intermediately suitable, and unsuitable according to the model. Darker areas (>0.45) should be considered suitable habitat (Latif et al. in prep).



The re-calibrated HSI models developed by Latif et al. (in prep) suggest that White-headed woodpeckers nest in parts of the landscapes with higher percent of ponderosa pine dominated stands, lower canopy cover, and higher edge density between open and closed stands. Five of the 7 variables were significant in one or both models (Table 8). Both models had positive relationships with percent of ponderosa pine, a negative relationship with slope, and the greatest habitat suitability at moderate canopy cover (approximately 30% to 50%). Both models also had high habitat suitability at similar densities of large trees (approximately 4-8 large trees/acre). Both models showed a positive relationship with landscape heterogeneity (edge density).

Available remote-sensed data are poor at capturing fine-scale habitat features important to WHWO nest habitat. The imprecision of the GNN-measured large tree density likely limited the models' ability to detect significant relationships with large-tree density. However, Hollenbeck et al. (2011) found field-measured large-tree density was an important predictor of nest survival rates.

Table 8. Variables used to model nesting habitat for White-headed woodpeckers across eastern Oregon (Latif et al. in prep).

Variable	Description	Significant component in model
Slope (SLP)	Pixel slope as % rise over run	Mahalanobis and Maxent
Cosine aspect	Pixel cosine-transformed orientation of slope	None
Local-scale canopy cover (LocCC)	% canopy cover for 2.5 acre neighborhood	None
Landscape-scale canopy cover (LandCC)	% canopy cover for 776 acre neighborhood	Mahalanobis and Maxent
Ponderosa pine (PIPO)	% ponderosa pine-dominated forest for 776 acre neighborhood	Mahalanobis and Maxent
Density large trees (TPH)	Number of large trees (>21 in dbh within 2.5 acre neighborhood	Mahalanobis
Edge density (ED)	Length of edge between alternate patch types for 776 acre landscape (1-10% cc; 10-40% cc; 40-80% cc)	Mahalanobis and Maxent

Refinement of the HSI model will continue as more data become available. The most current version of the model is available from RMRS via T:\FS\NFS\R06\Program\Wildlife-2600\WHWO\Data\RMRS_HSI or by request from the lead author.

Ecological Considerations

Ecological influences on survival and reproduction

In central Oregon, daily nest-survival rate (DSR - the probability that a nest will survive one day) and nest success were positively related to maximum daily temperature during the nesting period, and to densities of large-diameter trees (≥ 20 in dbh/acre) surrounding the nest tree (Hollenbeck et al. 2011). Temperature had a greater effect on DSR than density of large trees.

Higher temperatures likely increase activity of surface-bark insects that White-headed woodpeckers rely on during the breeding season, thus increasing foraging opportunities (Hollenbeck et al. 2011). Large trees near nests may increase foraging efficiency and parental attentiveness.

Wightman et al. (2010) found nest-success of White-headed woodpeckers was much higher in burned forests (76%) than in unburned forests (39%) in central Oregon (Frenzel 2004). Hollenbeck et al. (2011) speculate that ambient temperatures in burned areas may be higher which may have a positive effect on incubation behavior and reproductive effort.

Predator relationships and habitat

Wightman et al. (2010) and Frenzel (2004) found that predation was the most common cause of nest failure of White-headed woodpeckers. Frenzel (2004) found rodents and/or rodent droppings in many failed nest cavities. Smith and Maguire (2004), also working in central Oregon, found that an increase in shrub cover and down wood cover increases small mammal populations. Survival and densities of golden-mantled ground squirrels were higher in areas with higher down wood volume, and increases in total shrub and live bitterbrush cover coincide with increases in densities of yellow-pine chipmunks.

Frenzel (2004) found that successful nests had significantly lower shrub cover surrounding the nest site than unsuccessful nests (ANOVA, $p<0.05$). Nesting success was >40% at nest sites with < 40% shrub cover, while nesting success was <=20% at nest sites with >40% shrub cover. Nesting success was highest (>60%) at nest sites with <5% shrub cover. In Washington, Kozma and Kroll (2012) also found percent shrub cover had a negative effect on nest survival of White-headed woodpeckers (logit-link function, Akaike weight = 0.27). However, Hollenbeck et al. (2011) did not find shrub cover to be a significant component influencing nest survival.

Nests in unburned forests may be more vulnerable to predation by small mammals compared with burned forests (Hollenbeck et al. 2011). Both wildfire and prescribed fire have the potential to reduce down wood and shrub cover, and thus small mammal densities may be reduced for several years after fire (Saab et al. 2007, 2011, Wightman et al. 2010).

Higher densities of large-diameter trees near nest sites were documented by Hollenbeck et al. (2011) and Frenzel (2004). An abundance of large trees and nest cavities near nests may also reduce the efficiency of predators searching for occupied cavities relative to the surrounding forest (Hollenbeck et al. 2011).

Competitors

Hairy woodpeckers and White-headed woodpeckers are closely related species and overlap in range and habitat. Competition has been observed between the 2 species. Ligon (1973) reported interactions between Hairy woodpeckers and White-headed woodpeckers while feeding on cones. Both male and female Hairy woodpeckers supplanted female White-headed woodpeckers, while male White-headed woodpeckers were dominant to female Hairy woodpeckers.

Several studies have investigated similarities and differences in resource use by the White-headed and Hairy woodpeckers (Bull 1980, Kozma 2009, 2012, Kozma and Kroll 2012, Morrison and With 1987). Kozma (2012) found no differences between the 2 species in habitat used for nesting. However, White-headed woodpeckers initiated nesting later than Hairy woodpeckers, likely due to differences in availability of preferred prey used by each species (Kozma and Kroll 2012).

Morrison and With (1987) report behavioral differences between the 2 species with Hairy woodpeckers foraging higher in trees during winter, with further separation by foraging bouts occurring at different times of the day. In northeastern Oregon, Bull (1980) observed White-headed woodpeckers foraging exclusively on ponderosa pine, whereas Hairy woodpeckers foraged on a variety of tree species.

Ligon (1973) reported White-headed woodpeckers driving Pygmy nuthatch (*Sitta pygmaea*) and Red crossbills (*Loxia curvirostra*) away while feeding on pine cones. Mountain bluebirds (*Sialia currucoides*), Western bluebirds (*S. mexicana*), Pygmy nuthatches, and Violet-green swallows (*Tachycineta thalassina*) display aggression towards White-headed woodpeckers at nest sites, sometimes resulting in abandonment of nests (Garrett et al. 1996). Flying squirrels (*Glaucomys sabrinus*) and European starlings (*Sturnus vulgaris*) have also been observed usurping White-headed woodpecker nest cavities (Garrett et al. 1996).

Parasites and disease
Saab (pers. comm.) has observed adults abandon young that were covered with ectoparasites (bottleflies). The young appeared to be very lethargic. This was observed during a particularly wet year.

There have been no documented occurrences of West Nile Virus (WNV) in White-headed woodpeckers. However, the Centers for Disease Control (CDC) has documented occurrence in dead specimens of other species of woodpecker, including: Acorn woodpecker, Downy woodpecker (*Picoides pubescens*), Gila woodpecker (*Melanerpes uropygialis*), Hairy woodpecker, Lewis' woodpecker (*M. lewis*), Northern flicker, Nuttall's woodpecker (*Picoides nuttallii*), Red-bellied woodpecker (*M. carolinus*), Red-breasted sapsucker (*Spyrapicus nuchalis*), Red-headed woodpecker (*M. erythrocephalus*), and Yellow-bellied sapsucker (*S. varius*) ((http://www.cdc.gov/ncidod/dvbid/westnile/birdspecies.htm). According to the CDC, most species of birds infected with WNV survive.

Conservation

Threats to the Species

Habitat loss is the primary threat to White-headed woodpeckers (NatureServe 2008). Logging practices that target large ponderosa pine and snag removal, and fragment forests contribute to declines in habitat, especially in the northern half of the species range (Garrett et al. 1996). Fire suppression has led to changes in forest tree species composition and structure primarily due to the development of true fir (*Abies spp.*) in the understory. These changes have altered fire regimes, and as a result ponderosa pine forests are no longer maintained by frequent natural fire, which leaves the forests susceptible to stand-replacing fires (Nature Serve 2008).

Known Management Approaches
Fuels reduction and restoration treatments have been implemented with one of the objective being to improve habitat for White-headed woodpeckers. Restoration treatments in ponderosa pine forests in the eastern Washington Cascades had a positive effect on White-headed woodpeckers (Gaines et al. 2007, 2010). Relative abundance of White-headed woodpeckers was significantly ($P<0.05$) higher in treatments that combined thinning and burning, than in other treatment units or untreated control units (Gaines et al. 2010). The woodpecker was not detected in burn only treatments; using burning only usually does not provide habitat that is open enough to attract use by White-headed woodpeckers (Gaines et al. 2010). The woodpecker also had a high indicator species value for thinning treatments (Gaines et al. 2010). Gaines et al. (2007) detected White-headed woodpeckers only in treated stands, and in higher densities in low retention (20% pre-treatment basal area) treatments versus higher retention treatments. These low retention treatments had 90% of trees >10 in dbh and 74% of trees 11 to 15.8 in dbh removed during treatment; most trees over 15.8 in dbh were retained.

These studies provide support for the use of restoration treatments to enhance White-headed woodpeckers in dry forests. The retention of the large trees and snags and opening up of the overstory canopy through restoration treatments were likely important to the positive response to treatment by White-headed woodpeckers (Gaines et al. 2007). However, effectiveness monitoring will need to be implemented more broadly to determine if these treatments are effective at improving habitat conditions for the woodpecker across Oregon and Washington.

Management Considerations - Habitat Conservation and Restoration

Historical Context

Throughout the Pacific Northwest, shifts in forest structure and composition in low-elevation dry forests have been caused by timber harvest, fire exclusion and livestock grazing, and have increased the probability of unnaturally severe wildfire, insect outbreaks, and drought-related mortality (Hessburg and Agee 2003). The occurrence of older, larger trees (older than about 150 years) is far below Historic Range of Variability (HRV) and it takes centuries to replace these structures (Franklin and Johnson 2012, Hagmann et al. 2013, Harrod et al. 1999, Hessburg et al. 2005, Larson and Churchill 2012). Estimates of the amounts of old-growth ponderosa pine forest range from 3-15% of historic levels (Youngblood et al. 2004).

Historically, dry forests were shaped and maintained by a complex interaction of fire, insects and pathogens (Spies et al. 2006). Fire maintained low tree density, clumped tree distribution, light, patchy fuel beds, simple canopy layering, and fire-tolerant trees (Hessburg et al. 2005). Use of historical conditions can be used to inform restoration at multiple scales by providing insights into composition, structure and spatial patterns that supported low-severity fire regimes and associated wildlife species in the past (Churchill et al. 2013a, Harrod et al. 1999, Hessburg et al. 2005, Franklin and Johnson 2012, Spies et al. 2006, Youngblood et al. 2004).

Managing for historic conditions is expected to provide for resilience, even in the face of climate change, because these forests persisted through past climatic fluctuation and multiple disturbance events (Larson and Churchill 2012, Youngblood et al. 2004). Using HRV as a reference condition for restoration follows most of the strategies recommended for climate change adaptation (Churchill et al. 2013a).

Restoration of White-headed woodpecker habitat

Dry forest restoration treatments should help restore habitat for White-headed woodpeckers. Dry forests are defined as the ponderosa pine series, dry mixed conifer in the grand fir (*Abies grandis*) or white fir and Douglas-fir series (Brown et al. 2004, Hessburg et al. 2005, Spies et al. 2006) which are the same types that provide habitat for White-headed woodpeckers.

Based on habitat use by White-headed woodpeckers as described above in the ***Habitat*** section, restoration of their habitat should include:

- retaining and producing large, older ponderosa pine trees used for foraging;
- retaining and creating large snags used for nesting;
- reducing shrub cover and excess down wood to reduce numbers of small mammal which prey on nests;
- reducing canopy density across the landscape to provide interspersion of open and closed pine stands;
- maintaining within stand heterogeneity;
- reintroduction of rust-resistant white pine or sugar pine where appropriate would provide an alternative winter food source.

These restoration goals are similar to overall dry forest restoration goals: retain older/large fire resistant trees, reduce stand densities, incorporate spatial heterogeneity at stand and landscape scales (Churchill et al. 2013, Franklin and Johnson 2012, Hagmann et al. 2013, Harrod et al. 1999, Hessburg et al. 2005, Keeling et al. 2008, Larson and Churchill 2012)

Dry forest restoration goals are compatible with fuels reduction treatments, but involve more than just increasing fire resilience by reducing fuels and thinning dry forests everywhere on the landscape (Hessburg et al. 2007). An ecological approach that incorporates restoration of spatial and temporal patterns of forest structure (large, old trees, snags, down wood) and composition in order to restore ecosystem processes and functions is important. Recommendations include not over simplifying by applying the same methods or prescriptions across the entire landscape, and additionally emphasizing restoration of natural ecological processes rather than specific stand conditions (Churchill et al. 2013a, Hessburg et al. 2005, Keeling et al. 2006).

Treatment objectives

- Retain and protect large, older ponderosa pine trees

  Large, fire-resistant trees are important components of fire-safe forests (ponderosa pine, sugar pine, Douglas-fir) (Brown et al. 2004, Larson and Churchill 2012, Franklin and Johnson 2012). These trees are also critical components of White-headed woodpecker habitat, and restoration of large tree structure will be an important part of dry forest restoration treatments (Gaines et al. 2010).

  Current mean tree diameters are much lower than in historical stands, and large, old trees are rare on the landscape. Historical structural conditions can only be met by growing large, older trees. This will require time and protection from high severity disturbances (Harrod et al. 2009, Franklin and Johnson 2012). In addition to loss due to wildfire, competition with mid- or understory-trees increases drought stress and makes them susceptible to bark beetle attack and mortality (Kolb et al. 2007). Reducing tree density through thinning and/or prescribed fire reduces competition around large trees, which may improve vigor, and returns forest structure, and perhaps composition, closer to historical levels.

  Retention of large, old pine will often require protection during fuels reduction treatments. Prescribed fire can kill large trees that are intended to be saved by fuels treatment (Agee 2003, Brown et al. 2004, Swezy and Agee 1991, Youngblood et al. 2004). Even low-intensity prescribed burn may stress trees and attract bark beetles which can increase mortality of old trees for a number of years after the burn (Hood 2010, Kolb et al. 2007, Swezy and Agee 1991, Thomas and Agee 1986). Current fuel loads may be too high to achieve mortality of fir without excessive mortality of large pine; even low-intensity prescribed fires may direct successional trends away from desired conditions by killing old-growth ponderosa pine (Swezy and Agee 1991). Mortality rates of large, old ponderosa pine after prescribed burns range from 3.2% in the Sierras, to 11.4% in eastern Washington, to 50% in Crater Lake National Park (Fettig et al. 2010, Harrod et al. 2009, Swezy and Agee 1999). Other important pine species are also susceptible; in Crater Lake NP large (old 80-200 years) sugar pines died due to beetle attack between 1-4 years post burn (Thomas and Agee 1986).

Mortality from prescribed burns is caused directly by crown scorch or root collar damage. Trees with existing scars are more susceptible to mortality (Hood 2010, Hood et al. 2007). Fire can also cause fine root mortality that causes moisture stress and subsequent mortality from bark beetles (Hood 2010). Larger trees are more fire resistant, but also have larger fuel mounds that can cause bole scorch during prescribed fire (Thies et al. 2005). Fires of low intensity but long duration cause more damage to residual trees in terms of root collar heating (Thomas and Agee 1986). In northern California moisture content above 65 to 85% in duff at the base of ponderosa pine resulted in sustained smoldering, which can result in basal injury (Hood et al. 2007).

Forest Service managers in the Blue Mountains of Oregon are advised to rake orange, smooth-barked, ponderosa pine greater than 21 inches dbh and duff greater than 5-6 inches deep (D.Scott, personal communication). Additionally Hood (2010), after an extensive literature review, concludes that raking is a viable option when there is concern that burning will cause large-diameter, old ponderosa, and Jeffrey pine mortality. The following raking techniques are recommended to remove forest floor accumulations from the bases of trees based on the available literature and expert knowledge:

- Rake the majority of litter and duff away from the tree base. Raking litter only is not advisable in areas with low summer precipitation because the duff will dry significantly and ignite without litter
- Raking to mineral soil is not necessary except around fire scars. For trees without fire scars, leaving 2 to 3 inches of duff is acceptable in the West.
- Remove litter and duff at least 9 inches away from the tree base. Expand raking to 3 feet if shallow supporting roots are present. It is not necessary to remove material all the way to the drip line.
- Take care to spread raked material away from the tree in order to not create a new fuel mound around the tree.
- Rake during the fall or winter when fine root growth is minimal.
- If possible, allow at least one growing season between raking and burning to encourage new fine root development in the mineral soil on sites with numerous fine roots growing in the lower duff.

Duff removal around large-diameter and/or old trees allows managers to burn under a wider range of duff moisture scenarios without concern that the duff removal treatment alone will cause tree death (Hood et al. 2010). Though raking (or using a leaf blower) is intensive and potentially costly to implement, it is a one-time cost as raking pre-settlement trees is not necessary in subsequent burns. Scott and Spiegel (2007) reported an average raking cost of $16 to $20/tree for ponderosa pines in the Blue Mountains of Oregon. Basal duff depth and time to walk between trees will also impact treatment costs.

Other methods to protect large, old trees during prescribed burns are discussed in Hood (2010) and include: raking, snow well burning, hand lining, foaming, watering, fire-shelter wraps, and mechanical treatments.

- Grow more large trees

Thinning stands reduces stress on residual trees. Removing younger trees from around old trees increases water availability and can ameliorate the negative effects of severe drought (Kolb et al. 2007). Thinning should target removal of the small and medium-sized trees to move the stand composition towards fire- and drought tolerant species that provide candidates for replacement of old trees (Franklin and Johnson 2012, Hessburg et al. 2005). Target numbers of large/old pine should be 10 to 12 per acre based on Frenzel (2004) and corroborated by preliminary assessment of regional monitoring data (see ***Habitat*** section, Table 3).

- Retain, protect, and grow large snags

  To the extent possible, large snags (>20 inches dbh) should be retained and protected during treatments. Large snags are a rare component on the landscape in dry forests and take centuries to produce (Franklin and Johnson 2012, Hessburg et al. 2005). Fuels at the base of snags may need to be pulled back to protect them during prescribed burns.

  Roads facilitate the removal of snags as firewood and may necessitate removal for safety considerations (Gaines et al. 2003, Bate et al. 2007, Wisdom and Bate 2008). Road closures, especially in high quality habitat, may be required to maintain large snags. Restricting the size of trees that can be cut and collected for firewood to < 15 inches in diameter may also be a method to reduce loss of snags (Altman 2000a, 2000b).

  Growing large trees as replacement snags as described above, and maintaining natural levels of disturbance processes will be important to provide a continual supply of nest snags for White-headed woodpeckers.

- Maintain low amounts of shrub cover and down wood

  Past harvests and fire suppression has resulted in an increase of shrub cover and down wood compared to historical conditions in many areas. Densities of small mammals are higher in areas with high amounts of down wood and shrub cover (Smith and Maguire 2004). Increases in shrub cover can result in decreases in nest success for White-headed woodpecker, likely due to increased nest predation by small mammals (Kozma and Kroll 2012). Both wildfire and prescribed fire have the potential to reduce down wood and shrub cover, and small mammal densities may be reduced for several years after fire (Busse et al. 2009, Saab et al. 2007, 2011).

- Create landscapes with an interspersion of open and closed pine stands

  Provide spatial heterogeneity at the landscape scale that mimics historical conditions (Franklin and Johnson 2012, Hagmann et al. 2013, Harrod et al. 1999, Hessburg et al. 2005, Keeling et al. 2008). White-headed woodpeckers use relatively open landscapes. However, landscapes with a mosaic of open habitat for nesting in close proximity to closed-canopy forests which provide foraging habitat is important for White-headed woodpeckers (Hollenbeck et al. 2011).

  Historical disturbance regimes resulted in fine-grained mosaic driven primarily by topography (Spies et al. 2006). Most research on fire-exclusion effects on dry pine forests comes from southwest; further north ponderosa pine is seral to Douglas-fir or grand/white fir (Keeling et al 2006). These dry mixed conifer types were dominated by a mixed-severity fire regime; open, park-like ponderosa pine stands did not dominate the landscape, stand structure was more variable (Churchill et al. 2013, Keeling et al. 2006, Harrod et al. 1999, Hessburg et al. 2007, Youngblood et al. 2004). Even the dry ponderosa pine Potential Vegetation Type (PVT) had some (34%) mixed and high-severity fire (Hessburg et al.

2007). Franklin and Johnson (2012) recommend maintaining approximately 1/3 of the dry-forest landscape in denser patches; leaving these patches in less fire-prone areas. These less fire-prone areas are a function of topography and vegetation type. This recommendation fits well with what is known about landscapes used by White-headed woodpeckers (see *Landscape Scale Habitat* section above).

In the eastern Cascades, the range of the White-headed woodpecker overlaps areas being managed for northern spotted owls (*Strix occidentalis caurina*). Managing for both these species on the same acres will be challenging. Lehmkuhl et al. (2007) have developed a landscape-level approach to optimize habitat for both species using the FuelSolve optimization model. The optimization uses a coarse filter approach using HRV of open versus closed canopied forest. Stand level prescriptions are developed to intersperse habitat for both species in appropriate places to manage fire behavior using site-specific attributes.

- Retain and create spatial heterogeneity within stands

Provide spatial heterogeneity at the stand-scales mimics historical conditions (Franklin and Johnson 2012, Hagmann et al. 2013, Harrod et al. 1999, Hessburg et al. 2005, Keeling et al. 2008). Historically structure within stands in dry forests was a mosaic of openings, widely-spaced single trees, and tree clumps (Franklin and Johnson 2013, Larson and Churchill 2012, Youngblood et al. 2004).

Variable density thinning can mimic clumped distribution and associated processes found in historic stands (Brown et al. 2004, Harrod et al. 1999, Youngblood et al. 2004). Within stand mosaics were typically expressed at scales <1 acre (Larson and Churchill 2012). Areas over 2.4 acres of uniformly spaced trees are outside known reference conditions (Larson and Churchill 2012). Uniform treatments over large areas may increase the risk of unintended consequences and lead to less resilience to climate change (Churchill et al. 2013a).

Youngblood et al. (2004) describes clumps of trees as aggregation of upper canopy trees covering an area >22m in diameter for the east Cascades of Oregon and northern California. Harrod et al. (1999) estimated historical clump sizes ranged from 0.012 acres in mesic plots to 0.5 acre on the driest plots in the eastern Washington Cascades. Churchill et al. (2013a) describe clumps using an inter-tree distance threshold of 20 ft, the 33rd percentile of crown diameter for ponderosa pine. Clump size ranges from small clumps of 2 to 4 trees to large clumps up to 20 trees (Churchill et al. 2013a).

Prescriptions for stand treatments based on historical conditions have been developed for eastern Washington (Churchill et al. 2013a and 2013b, Harrod et al. 1999) and Oregon (Youngblood et al. 2004).

- Plant other pine species

Silvicultural treatments that include planting of disease-resistant sugar pine should be considered. White pine (*Pinus monticola*), white-bark pine (*Pinus albicaulis*), and Jeffrey pine may also be considered on appropriate sites. This will increase diversity of large-seeded pines on the landscape, which may increase the availability and reliability of seed crops important to White-headed woodpeckers (Garrett et al. 1996).

- Maintenance

  Maintenance of restored conditions after initial treatments will be important (Franklin and Johnson 2012, Hessburg et al. 2005, Busse et al. 2009, Wright and Agee 2004). Repeated reburning at 5- to 10-year intervals was required to curb rapid regrowth of shrubs (Busse et al. 2009).

- Monitoring

  Monitoring effects of treatments on stand and landscape structure will be important (Larson and Churchill 2012).

Treatment methods

Mechanical treatments, prescribed burns, or the combination of the 2 methods can be used to restore habitat for White-headed woodpeckers. Each method has advantages and disadvantages. Determining which methodology to use will depend on stand and site conditions. Below is some information from the literature to consider.

<u>Mechanical thinning</u>

It is easier to target leave trees by species, size, and spatial distribution using mechanical thinning than prescribed fire. There may also be commercial value associated with mechanical thinning. Mechanical treatments usually result in fewer snags than a prescribed burn or thin/burn treatment (Harrod et al. 2009, Vershuyl et al. 2011). In the eastern Washington Cascades about 70% of all snags, including 50% of snags ≥15.8 in dbh, were cut down during mechanical thinning operations primarily for safety concerns (Harrod et al. 2009). Designation of retention areas to protect snags may be one way to reduce the number of snags cut down for safety reasons.

Mechanical treatments are also prone to increase surface fuels and thus increase the risk of higher surface fire intensities for a period of time after harvest (Harrod et al. 2009).

<u>Prescribed burning</u>

Low to moderate-severity prescribed fire is effective at short-term reduction of shrub cover (Busse et al. 2009), and significantly reduces log cover (Youngblood et al. 2006), both of which may be beneficial for White-headed woodpeckers.

Harrod et al. (2009) found that prescribed burning increases snag density because more snags were created than lost. However, in the Sierras of California, Bagne et al. (2008) found a net loss of snags in burned stands as compared to controls. Snags created by prescribed fire do not have the same value as older snags lost due to prescribed fire; trees killed by prescribed burning are small (<7.9 in dbh) and lack decay making them of limited value to wildlife (Harrod et al. 2009). Burning may significantly increase the odds of snag fall (Harrod et al. 2009).

It is difficult to target which trees are killed or retained using prescribed fire. Prescribed fire can cause undesired mortality of live trees through direct or secondary effects (see Mortality of large pine above). White fir >16.8 in dbh may not be effectively removed by prescribed fire without causing significant mortality to residual pines (Thomas and Agee 1989). If prescribed fire kills groups of pine of any size in mixed conifer stands, the growing space may be captured by fir and potentially eliminate pine from an area (Thomas and Agee 1989). Even low-intensity prescribed fires may direct successional trends away from desired conditions by killing old-growth ponderosa pine (Swezy and Agee 1991). Piling and burning or other rearrangement of fuels, or more refined firing techniques, may be needed to maintain existing snags after fuels treatments are completed.

Mechanical treatment followed by prescribed burning

Increased surface fuels after mechanical thinning results in more trees killed by the prescribed burn (Harrod et al. 2009). Increased vigor in thinned stands may be offset by an increase in mortality of large trees if thinning is followed by prescribed fire. In northern California, 15% of large trees (>23.6 in dbh) were killed during prescribed fire after thinning; most mortality was secondary mortality that may be avoided by delaying burning a few years after thinning to allow recovery time (Ritchie et al. 2008).

Snag densities tend to be higher post-treatment using the combined treatment than in either thinning only or burning only (Harrod et al. 2009). Many of these snags may be of low value to wildlife for several years after treatment.

The short-term reduction of shrub cover (Busse et al. 2009), and significant reduction of log cover (Youngblood et al. 2006) resulting from prescribed fire would also occur when fire follows mechanical thinning. Log cover was significantly reduced in thinned and burned units compared to mechanical treatment and control units in NE Oregon (Youngblood et al. 2006).

Prioritization of treatments

Stands with the highest priority for restoration of White-headed woodpecker habitat are stands with large pine that are overstocked and at risk from uncharacteristic disturbance or drought stress. Mid-seral ponderosa pine stands (60-100 years old) are a secondary priority for restoration treatment, with the objective to release medium sized trees to develop larger, older trees and resilient stands (Brown et al. 2004).

Areas on the landscape that historically supported low-severity surface fires should be priorities for restoration treatments (Hessburg et al. 2005). Within these types, high productivity sites should be a priority because they accumulate biomass faster and tend to have high tree densities (Brown et al. 2004). Areas that historically supported mixed-severity fires should be the second priority for restoration treatments (Hessburg et al. 2005).

Habitat relationship models developed by Latif et al. (in prep) can be used to identify areas that are highly suitable for White-headed woodpeckers. Conservation efforts should focus on these areas. Areas that are not currently suitable but still in ponderosa pine dominated landscapes may benefit from restoration treatments.

Other Management Considerations

Seasonal Closures or Restrictions

There is no evidence that White-headed woodpeckers are susceptible enough to human disturbance to warrant seasonal restrictions except in the immediate vicinity of active nests. Nests of the birds have been observed along well-traveled roads, in campgrounds, and in housing developments (personal observation). However, protecting active nests from removal or prescribed fire would be prudent.

Salvage of post-fire habitat

Recent research has demonstrated the importance of post-fire habitat for White-headed woodpeckers (Forristal et al. 2007, Hanson and North 2008, Saab and Dudley 1998, Wightman et al. 2010). Nest survival rates in burned forests may be higher than rates in green forests (Frenzel 2004, Kozma and Kroll 2012, Wightman et al. 2010). The importance of this habitat should be considered when designing salvage sales in post-fire habitat.

The habitat relationship model developed by Wightman et al. (2010) can be used to inform managers of areas within a burn that may be important habitat for White-headed woodpeckers. When applying the model to areas outside south central Oregon, monitoring will be critical to validate applicability of the model to other areas.

The following information can be gleaned from the Wightman et al. (2010) model:

> At the landscape scale (0.621 mile radius) pre-fire open canopied ponderosa pine forest and a mosaic of burn severities best describe White-headed woodpecker habitat in burned forests. Specifically, nests were in landscapes that were about 70% open canopy (<40%) pre-fire and 37% of the landscape with moderate to high burn severity.
>
> At the nest-site scale (2.5 acre), relative probability of nest site selection increase with decreasing density of live trees, increasing snag decay class, and increasing nest snag dbh (Wightman et al. 2010). White-headed woodpeckers tended to select nest snags $\geq$ 164 feet from unburned or low intensity burned areas; 79% of nest sites had no live trees < 9 inches dbh in the nest-site vegetation plot.
>
> Snags existing before wildfire are critical habitat components in post-fire habitats. Fire-killed snags will take several years before they decay to a condition useable by White-headed woodpeckers.

The combination of live and dead large trees ($\geq$ 21 in dbh) at White-headed woodpecker nest sites appears to be similar between post-fire and green stands. Average tree and snag densities from Forristal et al. (2007) and Frenzel (2004) are 6 to 8 large dead and live trees combined. It may be that dead trees provide similar structure to live trees in post-fire habitat.

Landbird Conservation Strategies

Oregon-Washington Partners in Flight have developed conservation strategies for the east-slope of the Cascades and the northern Rocky Mountains of Oregon and Washington (Altman 2000a, 2000b). The White-headed woodpecker is a focal species for ponderosa pine or dry habitats in both ecoregions. Strategy objectives include no net loss of this habitat type, retention of all ponderosa pine trees and snags >20 inches dbh, use of natural disturbance regimes such as fire, and restoration of at least 30% of the potential late-successional forest by 2025. Specific population objective include increasing the number of established breeding populations (>10 pairs/area) to at least 20 new locations (5 in the Oregon Cascades, 5 in the Washington Cascades, 5 in the Blue Mountains, and 5 in the Northern Glaciated Mountains) by 2025.

Research, Inventory, and Monitoring Opportunities

Monitoring Strategy

A separate monitoring strategy has been developed for White-headed woodpeckers (Mellen-McLean et al. 2013). The strategy is designed to ensure consistent and scientifically credible sampling, data collection, and analysis protocols are used by the agencies in White-headed woodpecker inventorying and monitoring activities.

The strategy is a 3-pronged approach including: broad-scale occupancy and distribution monitoring; effectiveness monitoring; and validation monitoring for HSI models.

<u>Broad-scale occupancy and distribution monitoring</u>
The protocol is designed to provide reliable, standardized data on the distribution and site occupancy for White-headed woodpecker across their range in Oregon and Washington. The data can be used to better define habitat associations of White-headed woodpecker at the stand and landscape scales in the 2 states. Once base data are obtained, this protocol can be used to monitor change in the distribution and occupancy of White-headed woodpecker.

<u>Effectiveness monitoring</u>
The protocol is designed to provide reliable, standardized data on the effectiveness of treatments to restore or enhance habitat for White-headed woodpecker, and the impacts of treatments with other objectives (e.g., fuels reduction, salvage logging) on White-headed woodpecker across their range in Oregon and Washington. The data can be used to better define habitat associations of White-headed woodpecker, and to design treatments at the stand and landscape scales in the 2 states.

<u>Validation monitoring</u>
Validation and refinement of HSI models should be done with an independent data source. In addition, the models need to be refined for other areas outside central and southeast Oregon. New data on additional known White-headed woodpecker nesting locations in both burned and unburned landscapes are needed to accomplish model refinement and validation for other areas.

Ongoing Monitoring and Research
Broad-scale occupancy and distribution monitoring has been ongoing on Forest Service lands for 3 years, including one pilot year (Mellen-McLean and Saab 2013). There are 4 more years of monitoring planned under this monitoring project.

Validation monitoring for the HSI models developed by RMRS has been completed for the green forest models for central Oregon (Latif et al. 2012). Preliminary HSI models have been developed for the Blue Mountains of Oregon, but should be further validated as additional data become available (Latif et al. in prep). A preliminary model has yet to be developed or validated for Washington.

A research project in cooperation with the Yakima Tribe and University of Idaho is currently occurring on the southern Wenatchee National Forest (Lorenz et al. 2011, 2012). Objectives of the study are to determine features in the landscape effecting home range size and density of White-headed woodpecker, habitat use in stands dominated by young trees, evaluation of HSI models from central Oregon, nest success and survivorship. Additional funding will be needed to complete this research.

Monitoring and Research Needs

The Woodpecker Working Group identified several monitoring and research questions. We are beginning to get data and information to help answer some of the questions, but all are still legitimate questions to continue collecting information to answer.

- Salvage issues
    - How big a threat is fire salvage?
    - In burned habitat, how many snags and green trees should be retained to maintain reproductive capability?
    - How should they be distributed?
- Effectiveness monitoring of restoration treatments to determine:
    - How can we effectively restore habitat for this species?
    - What prescriptions should be recommended for restoration treatments to create suitable and future habitat for White-headed woodpeckers?
    - What are the effects of fuels treatments on White-headed woodpeckers?
- Metapopulation dynamics
    - Where are the source populations for species where recruitment outpaces mortality?
    - Why are some areas sources or sinks?
- Importance of ponderosa pine seeds
    - How important are other pines as a food source?
    - What happens when all pines have a poor cone crop?
    - Are White-headed woodpeckers using different foraging methods or strategies, and if so, what?
    - Are there certain conditions that promote or reduce cone production?
    - What is the relationship between cone cycles and White-headed woodpecker populations?

Other questions and issues have been posed by White-headed woodpecker researchers, including:

- HSI model development and calibration.
    - Unburned habitat models need to be developed and validated for Washington (Hollenbeck et al. 2011, Latif et al. 2012, in prep).
    - Burned habitat models (Wightman et al. 2010) are currently being validated in southeastern Oregon.
- What is the relationship of survivorship and productivity to ponderosa pine seed production? (Lorenz et al. 2012)
- What are adult mortality rates from January through April? (Lorenz et al. 2012)
- Are young stands population sources or sinks for White-headed woodpeckers? (Kozma and Kroll 2012)

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